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A Systematic Review of Stem Cells in Iraqi Studies

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ABSTRACT

Over the past three decades, stem cell therapy has undergone rapid development and has emerged as a novel treatment for many major disorders. This systematic review aims to analyze the current landscape of stem cell research publications in Iraq comprehensively. By identifying and critically evaluating existing progress, this review provides a robust overview of the field, informing the development of a well-designed national roadmap for future advancements. This analysis serves as a valuable scientific reference both within Iraq and internationally, fostering further progress in Iraqi stem cell research. Data on Iraqi stem cell publications were collected from scientific databases such as the Iraqi Academic Scientific Journals Database, Google Scholar, Scopus, PubMed, Science Direct and other search engines. These publications were classified and analyzed to evaluate their status in the field. In our systematic review, we analyzed 132 articles on Iraqi stem cell research, including 21 review articles, 9 cancer stem cell studies, and 102 methodological studies, spanning from 1977-2024. Our findings highlight a rapid increase in publications, particularly in recent years, demonstrating significant progress in stem cell research within Iraq. Key areas of focus include the therapeutic applications of stem cells, cancer stem cells, and methodological advancements, with the majority of studies utilizing human, mouse, and rat samples. This comprehensive analysis underscores the evolving landscape and the need for continued collaboration and strategic planning in Iraqi stem cell research. Our systematic review revealed a significant increase in Iraqi stem cell research publications over recent years. This growth reflects substantial progress and the critical need for continued collaboration and strategic planning to further advance the field.

Keywords: Cancer stem cells; Clinical trial; Iraqi studies; Stem cells; Systematic review

INTRODUCTION

Stem cells are of interest because of their biological properties and potential medical importance in treating and repairing injured and damaged tissues. These cells are characterized by their capacity for proliferation, self-renewal, and differentiation into a large number of specialized progeny, making them essential for tissue regeneration[1]. Consequently, stem cells are a cornerstone of regenerative and cellular therapies for many serious diseases. A stem cell is a single cell that can replicate itself to produce identical daughter cells or differentiate into specialized cell types of embryonic or adult tissues. Stem cells are classified in two main ways: by their developmental potency or by their origin. Based on potency, they are divided into totipotent, pluripotent, and multipotent stem cells. Based on origin, they are classified as embryonic, umbilical cord, or adult stem cells[2].

Given the proliferation of Iraqi studies in this field, a systematic review is necessary to synthesize the available evidence. A systematic review is a rigorous research methodology that aims to identify, select, and synthesize all research published on a specific question or topic. It adheres to a strict, pre-specified, and reproducible scientific design to provide reliable estimates and a comprehensive overview of the evidence[3]. Beyond illustrating current knowledge

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about a topic, systematic reviews also identify gaps in the literature. The process involves a transparent and systematic approach to define a research question, search for studies, assess their quality, and synthesize findings qualitatively or quantitatively[3]. A crucial first step is to thoroughly define the scope of the research question, which requires a deep understanding of the existing literature, including its definitions, uncertainties, and conceptual frameworks[3]. When appropriate, a meta-analysis, which uses statistical methods to summarize the results of the included studies, may also be performed [4].

This review focuses specifically on Iraqi research in the stem cell field. By conducting a systematic review, we aim to assess the extent and nature of this research through the systematic collection and summarization of all published outcomes that fit our pre-specified eligibility criteria. This will provide a valuable overview based on the available published articles.

MATERIALS AND METHODS

This study was carried out at the Experimental Therapy Department, Iraqi Center of Cancer and Medical Genetics Research (ICCMGR), Mustansiriyah University, Baghdad, Iraq. The scientific committee of ICCMGR (serial number 1 in 1/25/2021) approved this work.

Inclusion and exclusion criteria

The process of study selection was performed by identifying relevant Iraqi publications about stem cells. The inclusion criteria of all the articles used in this study were selected on the basis of their titles, abstracts, methods, and results, which are relevant to the outcomes of interest. All other studies were excluded if they did not meet the eligibility criteria. Each study was eligible if it fulfilled the following eligibility criteria: (i) full text available (ii) published; (iii) conducted in Iraq by Iraqi researchers. If more than one study presented the same data, the study with more complete data was included.

Study Selection and Data Collection

Published data on Iraqi stem cell publications were collected from scientific databases such as the Iraqi Academic Scientific Journals Database, Google Scholar, Scopus, PubMed, ScienceDirect and other search engines. These publications were classified and analyzed to evaluate their status in the field. Eligible studies were published between 1977 and 2024. The following data were extracted from each included study: name of the first author, year of publication, type of organism, type of study, type of sample, type of organ or tissue or cells, and type of technique.

Statistical analysis

The study was conducted in accordance with the PRISMA guidelines (Preferred Reporting Items for Systematic Reviews)[5]. The PRISMA checklist was used to ensure the inclusion of relevant information in the analysis (Figure 2).

Statistical analysis for systematic review was performed via IBM SPSS (International Business Machines Corporation, IBM) (Statistical Package for the Social Sciences, SPSS) Statistics Software (version 25) to determine the frequencies, percentage values, and pie charts for all the variables used in this study.

RESULTS

A total of 146 articles were used in this study. 132 studies were eligible for the systematic review, which included 21 review studies, 9 cancer stem cell studies, and 102 methodological studies. The remaining 14 papers were excluded (Figures 1 and 2).

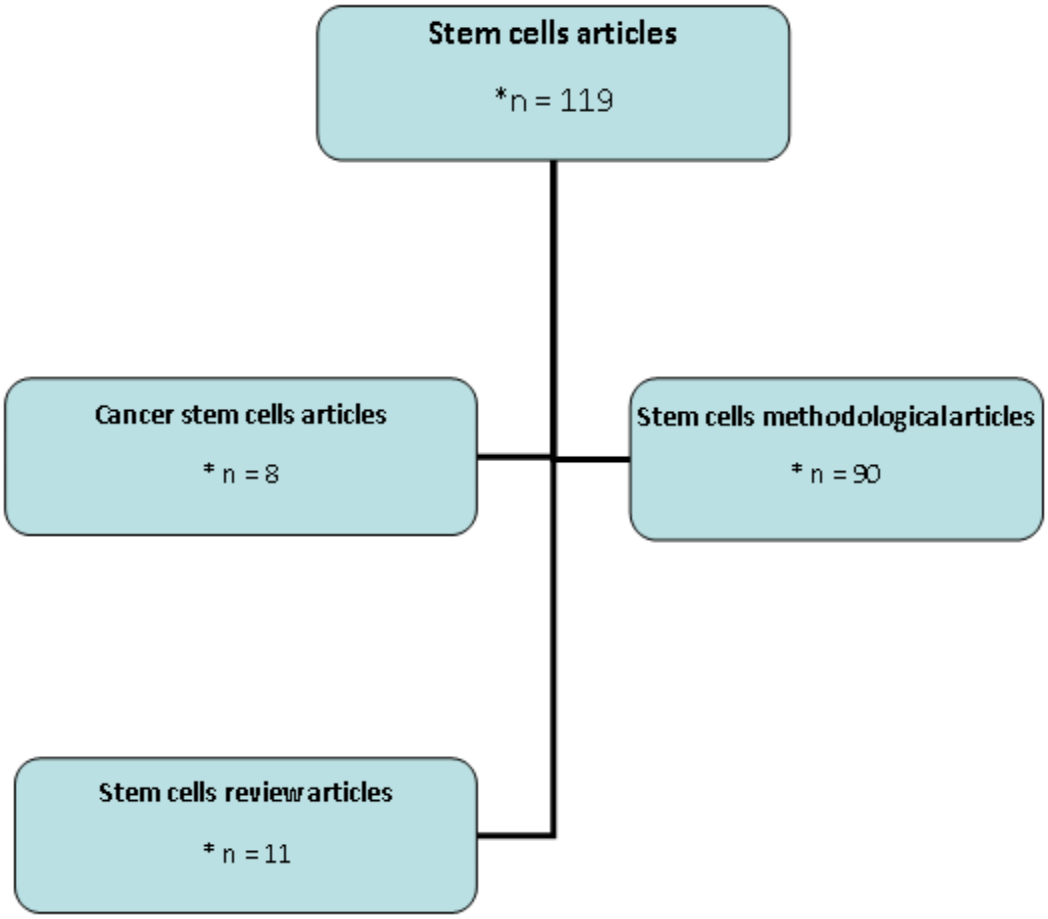

Figure 1. The division of Iraqi stem cells studies

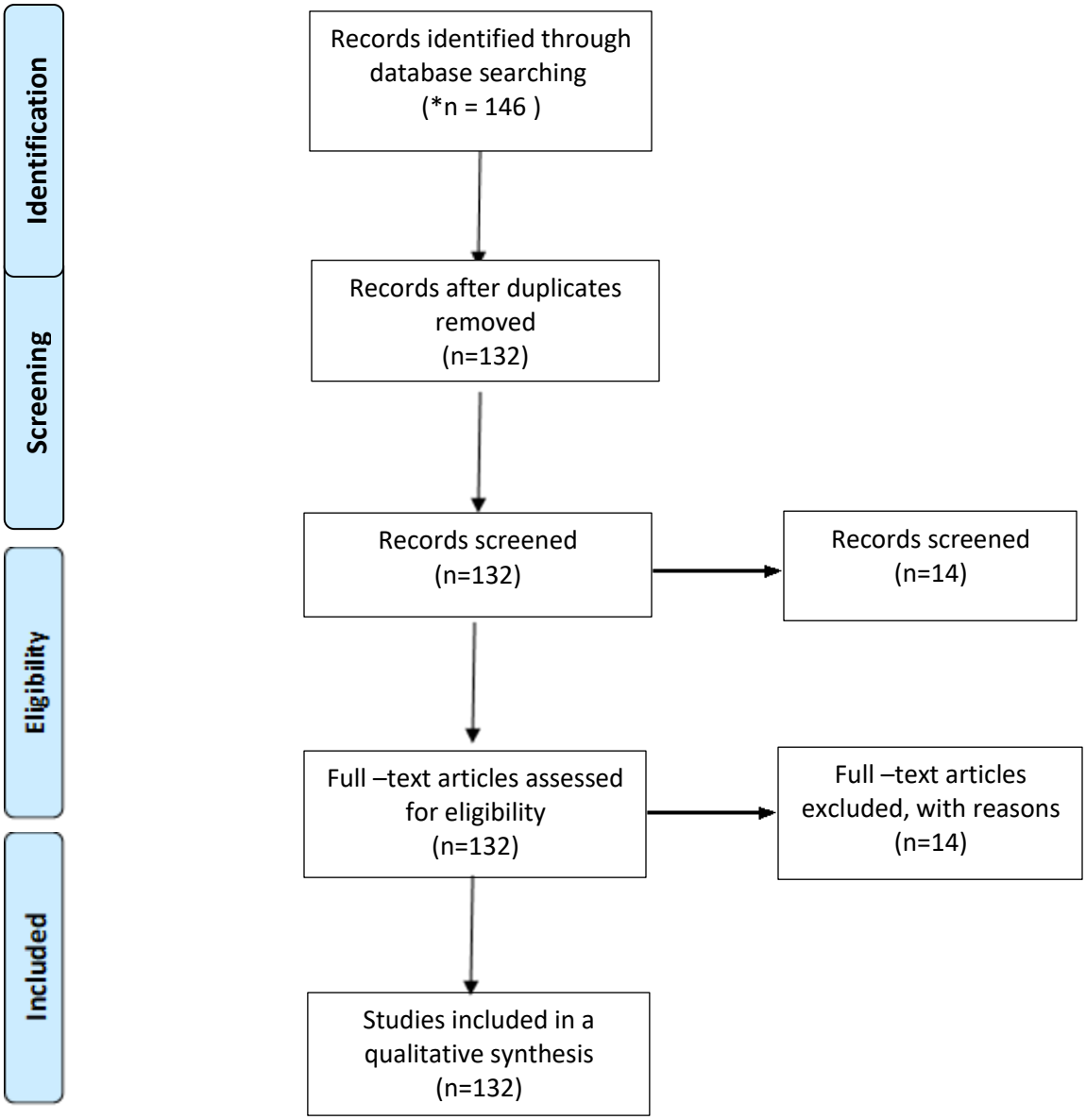

Figure 2. Flow diagram of the study selection process for the systematic review (*From:* Moher et al.)[5]
*n = number of publication articles
*n = number of articles.

Study characteristics

In our systematic review, we identified 132 eligible studies, which were categorized into three types (as outlined in Figure 2). These comprised 21 review articles, 9 cancer stem cell studies, and 102 methodological studies. An overview of the review articles, including the first author, publication year, and article link, is presented in Table 1. The characteristics of the cancer stem cell studies—such as first author, publication year, type of organism, study design, sample type, organ/tissue/cell source, technique used, and article link—are summarized in Table 2. The methodological studies (n=102) are detailed in Table 3, which lists the same extracted data: first author, publication year, type of organism, study design, sample type, organ/tissue/cell source, technique used, and article link (Table 3).

Table 1. Characteristics of the review studies included in the systematic review

	authors first name	year	link
1	Alauldeen Mudhsfar	2016	https://doi.org/10.29409/ijcmg.v9i1.177
2	Ban J. Qasim	2015	https://iraqijms.net/index.php/jms/article/view/81
3	Saba S. Alsarraj	2014	https://jbcd.uobaghdad.edu.iq/index.php/jbcd/article/view/523
4	Amina N. Althwani	2007	https://scholar.google.com/citations?view_op=view_citation&hl=en&user=Ch_fzIAAAAAJ&cstart=200&pagesize=100&sortby=pubdate&citation_for_view=Ch_fzIAAAAAJ:dTyEYWd-f8wC
5	Waheed K. Ibrahim	2014	https://www.iasj.net/iasj?func=fulltext&aId=97422
6	Khalifa E. Sharquie	2016	http://www.odermatol.com/2016-2-11/
7	Araz Jaffar	2009	https://research.amanote.com/publication/4ZX22HMBKQvf0Bhi6EJZ/effect-of-over-dose-synthetic-estradial-17---hormone-on-some-peripheral-blood-parameters
8	Talib Fadhi Al-Zayadi	2019	https://muthmj.mu.edu.iq/cgi/viewcontent.cgi?article=1061&context=journal
9	Omar T. Hammoodi	2020	https://doi.org/10.31838/ijpr/2020.12.01.197
10	Navid Shomali	2020	https://onlinelibrary.wiley.com/doi/abs/10.1002/jcp.29324
11	Satar J. Rahi	2020	https://medic.upm.edu.my/upload/dokumen/2020042010381637_MJMHS_0147.pdf
12	Thekra Abdulaali Abed	2022	https://cdnx.uobabylon.edu.iq/research/MwBgS0vD5kOQ8AjqkIa00w.pdf
13	Ghassaq T. Alubaidi	2022	https://journals.lww.com/mjby/fulltext/2022/19030/stem_cells__biology,_types,_polarity,_and.2.aspx
14	E.K AL-Hamdany	2022	https://www.researchgate.net/publication/362311257_Identification_and_Characterization_of_Canine_Mammary_Tumors_Stem_Cells_A_Review
15	Mustafa Bakhtiar Wend	2023	https://search.mandumah.com/Record/1382281/Details
16	Zainab Abdelelah Abdel Kareem	2022	https://uomosul.edu.iq/en/regionalstudiescenter/wp-content/uploads/sites/27/2024/05/The-Position-of-Heavenly-Religions-and-Legislation-on-Stem-Cell-Therapy-Experiments.pdf
17	Mustafa Bakhtiar Wend	2023	https://mabdaa.edu.iq/wp-content/uploads/2023/03/3-%D8%A7%D9%84%D8%AD%D9%83%D9%85-%D8%A7%D9%84%D8%B4%D8%B1%D8%B9%D9%8A-%D9%84%D9%84%D8%B9%D9%84%D8%A7%D8%AC-%D8%A8%D8%A7%D9%84%D8%AE%D9%84%D8%A7%D9%8A%D8%A7-%D8%A7%D9%84%D8%AC%D8%B0%D8%B9%D9%8A%D8%A9.pdf
18	Ala'a Abdul-Nabi al-Medeni	2023	https://search.mandumah.com/Record/1407173/Details
19	Methaq Mueen Al-Kaab	2021	https://doi.org/10.29409/ijcmg.v14i1.322
20	Noah A. Mahmood	2022	https://www.semanticscholar.org/paper/Cancer-Stem-Cell-Markers-in-Iraqi-Patients-with-Mahmood/26b789f24991289d12256f2ad3326bf21262f7d9
21	Mohammed Siddiq Mohammed	2021	https://search.mandumah.com/Record/1236434

Table 2. Characteristics of human cancer stem cell studies included in the systematic review

	Authors first name	Year	Type of sample	Type of organ, tissue, cell	Technique	Link
1	Teeba k. Hadi	2014	Breast cancer tissue	tissue	*IHC	https://www.semanticscholar.org/paper/Detection-of-cancer-stem-cell-in-invasive-ductal-of-Hadi-Edan/68845afb48c4eabd9a8363d8e672ca90ff396482
2	Ahmed M. Hassan	2017	Renal cell carcinoma tissues	tissue	IHC	https://iraqijms.com/index.php/jms/article/view/494
3	Zaynab S. Abdulghany	2018	Cancer cell lines	cell line	Molecular	https://doaj.org/article/99ea93b5db0d4ec4b210f788148aadfd
4	Ramadhan T. Othman	2008	Brain tumor	tissue	**ICC	https://pesquisa.bvsalud.org/gim/resource/pt/emr-86155
5	Samar A. Alshami	2018	Ovarian tumor	tissue	IHC	https://iraqijms.net/index.php/jms/article/view/628
6	Murooj J. Mohammed	2019	Urinary bladder cancer	tissue	IHC	http://dx.doi.org/10.22159/ajpcr.2019.v12i6.33189
7	Hadeel I. Mohasen	2019	Prostate cancer	tissue	IHC	http://dx.doi.org/10.22159/ajpcr.2019.v12i6.33612
8	Noah A. Mahmood	2019	Papillary Thyroid Carcinoma	tissue	IHC	https://doi.org/10.1155/2019/1659654
9	Noorhan Sabih Al-Maliki	2024	Blood	***AML	Molecular	https://doi.org/10.54133/ajms.v6i1.577

* Immunohistochemistry
** Immunocytochemistry
*** Acute myeloid leukemia

Table 3. Characteristics of the methodological studies included in the systematic review

	Authors first name	Year	Type of organism	Type of study	Type of sample	Type of organ, tissue, cell	Technique	Link
1	Cheia Majeed	2015	Mouse	treatment	MSCs*	bone marrow	IHC	http://dx.doi.org/10.4236/scd.2015.54004
2	Rafal H. Abdalla	2016	Mouse	differentiation	MSCs	bone marrow	ICC	https://www.researchgate.net/publication/305932980
3	Ahmed M. Alshammari	2012	Mouse	isolation	NSCs**	brain	ICC	https://doi.org/10.1016/S1525-0016(16)36326-2
4	Akram R. Jabur	2017	Mouse	Tissue engineering	MSCs	bone marrow	Scanning electron microscope	https://doi.org/10.1016/j.egypro.2017.07.048
5	Baydaa A. Alqaisy	2014	Mouse	isolation	MSCs	bone marrow	microscopic	http://www.researchgate.net/publication/265784313
6	Baydaa A. Alqaisy	2014	Mouse	isolation	MSCs	bone marrow	ICC	http://www.researchgate.net/publication/265742747
7	Ahmed M. Alshammari	2013	Mouse	differentiation	MSCs	bone marrow	ICC	http://www.researchgate.net/publication/236651096
8	Ahmed M. Alshammari	2015	Mouse	differentiation	MSCs	bone marrow	ICC	https://www.researchgate.net/publication/274387098
9	Maeda H. Mohammad	2016	Mouse	differentiation	MSCs	bone marrow	ICC	https://www.researchgate.net/publication/282365388
10	Maeda H. Mohammad	2016	Mouse	molecular study	MSCs	bone marrow	molecular	https://doi.org/10.2147/SCCAA.S94545
11	Athraa Y. Al-Hijazi	2013	Mouse	isolation	Amniotic stem cells	tooth	IHC	https://jbcd.uobaghdad.edu.iq/index.php/jbcd/article/view/233
12	Zauhair A. Jaumh	2008	Rat	differentiation	Hepatic oval stem cells	Hepatic tissue	ICC	https://iqjmc.uobaghdad.edu.iq/index.php/19JFacMedBaghdad36/article/view/1238
13	Raed H. Mohammed	2012	Rat	isolation	MSCs	bone marrow	ICC	https://pharmacy.uokerbala.edu.iq/wp/wp-content/uploads/sites/6/2014/10/pharmacy.uokerbala.edu.iq_images_journal_3rd%20non_6.pdf
14	Majeed Arsheed Sabbah	2011	Human	isolation	UCBSCs***	placenta	ICC	https://ijcmg.uomustansiriyah.edu.iq/index.php/ijcmg/article/view/58
15	Mohamed A. Mohammad	2013	Rabbit	treatment	MSCs	bone marrow	ICC	https://jbcd.uobaghdad.edu.iq/index.php/jbcd/article/view/205
16	Sarah M. Alsawalha	2015	Human	isolation	MSCs	bone marrow	ICC	https://ijs.uobaghdad.edu.iq/index.php/eijs/article/view/9756
17	Oday K. Luaibi	2015	Dog	treatment	MSCs	bone marrow	IHC	https://www.semanticscholar.org/paper/Comparative-study-between-the-effect-of-stem-cells-Luaibi/ea11bd59c52a005e66b5e3ec4894dc3ef416f49c
18	Oday K. Luaibi	2016	Dog	transplantation	MSCs	bone marrow	IHC	file:///C:/Users/hp/Downloads/166-Article%20Text-215-1-10-20181205.pdf
19	Intidar M. Manati	2009	Human	differentiation	MSCs	bone marrow	ICC	https://jih.uobaghdad.edu.iq/index.php/j/article/view/1135
20	Abdulmajeed A. Homadi	2011	Human	transplantation	HSCs****	peripheral blood	Clinical response criteria	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3840965/
21	Al Azawwi I.N.	2003	Mammalian	isolation	ESCs*****	embryo	ICC	Ph.D. Thesis, College of Science, Al-Mustansiriyah Univ
22	Ahmed H. Al Bayaty	2010	Horse	treatment	MSCs	bone marrow	ICC	Ph.D. Thesis, College Veterinary Medicine. University of Baghdad
23	Al Jumely B.A.	2006	Mouse	isolation	MSCs	bone marrow	ICC	M.S.c. Thesis, College of Science, University of Baghdad

	Authors first name	Year	Type of organism	Type of study	Type of sample	Type of organ, tissue, cell	Technique	Link
24	Al Kubaysi S. M.	2012	Ewe	treatment	HSCs	peripheral blood	ICC	https://www.researchgate.net/publication/323664190_USING_THE_HEMATOPOEITIC_STEM_CELLS_TO_TREAT_THE_IMMUNE_DEFICIENCY_IN_EWES#fullTextFileContent
25	Athraa Y. Alhijazi	2013	Mouse	treatment	Amniotic stem cells	tissue	IHC	https://jbcd.uobaghdad.edu.iq/index.php/jbcd/article/view/233
26	Intidar M. Manati	2009	Rat	isolation	MSCs	bone marrow	ICC	https://jih.uobaghdad.edu.iq/index.php/j/article/view/1135
27	Karim A.M.	2013	Rat	treatment	MSCs	bone marrow	IHC	Ph.D. Thesis, College of Science for wemen, University of Baghdad
28	Intidar M. Manati	2007	Rat	treatment	MSCs	bone marrow	IHC	Ph.D. Thesis, College of Education (Ibn Al-Hitham), University of Baghdad
29	Mohamed A. Mohammad	2011	Rabbit	treatment	MSCs	bone marrow	IHC	Ph.D. Thesis, College Dentistry, University of Baghdad, Iraq
30	Baydaa H. Mutlak	2007	Human	treatment	UCBSCs	placenta	IHC	Ph.D. Thesis, College of Education (Ibn Al-Hitham), University of Baghdad
31	Muthanna I. Malik	2016	Mouse	Genetic study	MSCs	bone marrow	microscopic	file:///C:/Users/hp/Downloads/Cytogeneticeffectsofalbendazoleonstemcellsmicebone.pdf
32	Faruk H. Al Jawad	2016	Human	Toxicity	HSCs	peripheral blood	microscopic	https://doi.org/10.29409/ijcmg.v9i1.181
33	Araz J. Mohamad	2009	Rat	Toxicity	MSCs	bone marrow	microscopic	https://research.amanote.com/publication/4ZX22HMBKQvf0Bhi6EJZ/effect-of-over-dose-synthetic-estradial-17---hormone-on-some-peripheral-blood-parameters
34	Rihab Nasr	2012	Mouse	molecular	MSCs	bone marrow	flowcytometry	https://ddl.mbrf.ae/book/8065104
35	Intissar N. Waheed	2011	Human	differentiation	UCBSCs	placenta	ICC	https://www.researchgate.net/publication/346333881_Neural_Cell_Differentiation_of_Mesenchymal_Stem_Cells_Isolated_from_Human_Umbilical_Cord_Blood_In_Vitro
36	Shalal M. Hussain	2015	Mouse	differentiation	MSCs	bone marrow	ICC	https://anjs.edu.iq/index.php/anjs/article/view/294/240
37	Abdulmajeed A. Homadi	2017	Human	transplantation	HSCs	bone marrow	Clinical response criteria	http://ectrx.org/forms/ectrxcontentshow.php?doi id=10.6002/ect.mesot2016.P21
38	Mahfoodha A. Umran	2016	Mouse	differentiation	MSCs	tissue	ICC	https://www.researchgate.net/publication/331974756_Comparative_Study_of_Expansion_and_Proliferation_of_Adult_Mice_Mesenchymal_Stem_Cells_Derived_from_Bone_Marrow_and_Adipose_Tissue
39	Ali Hasan	2011	Mouse	Toxicity	MSCs	bone marrow	microscopic	https://www.researchgate.net/publication/216868796
40	Raja Kummoona	2018	Rabbit	treatment	MSCs	bone marrow	microscopic	https://doi.org/10.15436/2471-0598.18.1879
41	Araz J. Mohamad	2009	Rat	Toxicity	MSCs	bone marrow	Cytotoxicity assay	https://research.amanote.com/publication/4ZX22HMBKQvf0Bhi6EJZ/effect-of-over-dose-synthetic-estradial-17---hormone-on-some-peripheral-blood-parameters
42	Intissar N. Waheed	2014	Rat	treatment	MSCs	bone marrow	IHC	https://doi.org/10.5897/AJB2014.13751
43	Majeed A. Sabbah	2017	Human	molecular	HSCs	bone marrow	molecular	file:///C:/Users/hp/Downloads/ijcmgadmin,+Journal+manager,+129034.pdf
44	Mohanad Kh. Alani	2015	Rat	treatment	MSCs	bone marrow	IHC	http://dx.doi.org/10.1155/2015/984146
45	M. A. Aladhami	1977	Fish	isolation	HSCs	embryo	microscopic	https://doi.org/10.1111/j.1440-169X.1977.00171.x

	Authors first name	Year	Type of organism	Type of study	Type of sample	Type of organ, tissue, cell	Technique	Link
46	Intissar N. Waheed	2010	Rat	differentiation	MSCs	bone marrow	ICC	https://www.researchgate.net/publication/275461815
47	Layla Alhasan	2015	Rat	treatment	MSCs	bone marrow	molecular	https://doi.org/10.1039/C5IB00206K
48	Athraa Y. Alhijazi	2015	Rat	treatment	MSCs	bone marrow	IHC	https://www.eajournals.org/wp-content/uploads/Expression-of-BMP7-in-bone-tissue-treated-with-Aloe-Vera.pdf
49	Nasheet G. Mustafa	2013	Mouse	molecular study	NSCs	brain	molecular	https://www.researchgate.net/publication/275274394
50	Baydaa H. Mutlak	2008	Human	differentiation	UCBSCs	placenta	ICC	https://www.researchgate.net/publication/275462281
51	Haidar H. Alfatlawi	2016	Human	Markers expression	HSCs	peripheral blood	flowcytometry	DOI: 10.4103/2072-8069.198119
52	Farooq I. Mohammad	2012	Human	molecular study	ESCs	embryo	molecular	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3459939/
53	Mohammed A. Alzubaidi	2016	Human	molecular study	MSCs	bone marrow	molecular	https://pubmed.ncbi.nlm.nih.gov/27783707/
54	M. H. Mohammed	2012	Chicken	Virus replication	MSCs	embryo	ICC	http://jwpr.science-line.com/index.php?option=com_content&view=article&id=13&Itemid=15
55	Intissar N. Waheed	2010	Mouse	differentiation	ESCs	embryo	ICC	http://jjbs.hu.edu.jo/files/v4n3/final%20published%2022-8-2011.pdf
56	Entedhar K. Hussain	2015	Human	differentiation	UCBSCs	placenta	ICC	https://www.researchgate.net/publication/275462424
57	Abdul-Jabbar F. A.	2019	Human	differentiation	NSCs	brain	ICC	http://www.mmjonweb.org/text.asp?2018/17/2/69/24611
58	Bassim A. Jassim	2016	Rabbit	Histological study	ESCs	embryo	IHC	https://www.researchgate.net/publication/330738914_Histological_study_of_development_liver_in_Indigenous_Rabbits_Fetuses
59	Hana Kh. Ismail	2020	Mouse	Protective effect	MSCs	placenta	IHC	https://www.semanticscholar.org/paper/Protective-effect-of-placental-mesenchymal-stem-on-Ismail-Al-Sabawy/388a6e4fe9fbd9a238b8428226eb590abe9b781d
60	Hebat Alla A. Abdulla	2018	Human	Toxicity	UCBSCs	placenta	microscopic	https://scholar.google.com/citations?view_op=view_citation&hl=en&user=1b9zEW0AAAAJ&citation_for_view=1b9zEW0AAAAJ:7PzlFSSx8tAC
61	Maeda H. Mohammad	2020	Mouse	differentiation	MSCs	tissue	ICC	https://dx.doi.org/10.21123/bsj.2020.17.1(Suppl.).0235
62	Nidal K. Alrahal	2011	Human	cryopreservation	PBSCs********	bone marrow	microscopic	https://www.academia.edu/78499864/Alternative_Methods_of_Cryopreservation_of_Human_Peripheral_Blood_Stem_Cells_for_Marrow_Transplantation
63	Oday K. Luaibi	2015	Dog	treatment	MSCs	bone marrow	IHC	https://www.semanticscholar.org/paper/Comparative-study-between-the-effect-of-stem-cells-Luaibi/ea11bd59c52a005e66b5e3ec4894dc3ef416f49c
64	Wafaa Mohammed	2014	Human	transplantation	mononuclear cell	bone marrow	Clinical response criteria	file:///C:/Users/hp/Downloads/Complications_For_Bone_Marrow_Transplant.pdf
65	Zahra Altimimi	2018	Mouse	isolation	MSCs	Bone marrow	ICC	https://www.mendeley.com/catalogue/627fed12-7d4e-3687-92a1-04c84ea79793/
66	Zeyad A. Shabeeb	2018	Human	differentiation	UCBSCs	placenta	microscopic	https://www.iasj.net/iasj?func=fulltext&aId=165193
67	Maeda H. Mohammad	2019	Mouse	differentiation	MSCs	bone marrow	ICC	https://www.worldresearchersassociations.com/BiotechSpecialIssueMarch2019/42.pdf

	Authors first name	Year	Type of organism	Type of study	Type of sample	Type of organ, tissue, cell	Technique	Link
68	Omar A. Hamid	2016	Mouse	Tissue engineering	ESCs	embryo	ICC	https://www.researchgate.net/publication/307147622
69	Abdulmajeed A. Homadi	2019	Human	clinical trail	mononuclear cell	bone marrow	Clinical response criteria	https://pubmed.ncbi.nlm.nih.gov/30777565/
70	Snur M. A. Hassan	2019	Mouse	Markers expression	colon	tissue	IHC	https://doi.org/10.1155/2019/5134156
71	Nawal M Abdullah	2017	Human	Markers expression	colon	tissue	IHC	file:///C:/Users/hp/Downloads/Immunohistochemicalexpressionofnonneoplastictumorsofcolon.pdf
72	Marta C.	2019	Human	transplantation	HSCs	peripheral blood	Clinical response criteria	https://pubmed.ncbi.nlm.nih.gov/30915157/
73	Rafal H. Abdalla	2018	Mouse	isolation	MSCs	bone marrow	ICC	http://doi.org/10.23937/2469-570X/1410054
74	Fadhel F. Kadhum	2019	Human	transplantation	mononuclear cell	bone marrow	Clinical response criteria	http://www.indianjournals.com/ijor.aspx?target=ijor:ijphrd&volume=10&issue=1&article=166
75	Khalida I. Noal	2019	Human	Markers expression	Prostatic Carcinoma	tissue	IHC	https://www.researchgate.net/publication/340645736
76	Hassan M. Abass	2020	Human	transplantation	PBSCs	bone marrow	Clinical response criteria	https://www.mdpi.com/2218-0532/88/1/12/pdf
77	Buthainah Alazzawi	2020	Human	differentiation	MSCs	bone marrow	ICC	file:///C:/Users/user/Downloads/The_Secretome_of_Mesenchymal_Stem_Cells_Prevents_I.pdf
78	Hamid H. Enezei	2020	Human	molecular study	Dental stem cells	Cell line	molecular	https://www.researchgate.net/publication/338954382
79	Jean El-Cheikh	2019	Human	treatment	PBSCs	bone marrow	Clinical response criteria	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6349008/
80	Hassein A. Altoban	2018	Human	transplantation	mononuclear cell	bone marrow	molecular	http://www.ijhonline.org/temp/IraqiJHematol8138-5520392_152003.pdf
81	Sarkawt Hamad	2019	Human	differentiation	hiPSC-******CMs*	tissue	molecular	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6831300/
82	Rasha H. Dosh	2019	Mouse	differentiation	Intestinal stem cells	tissue	IHC	https://pubs.rsc.org/en/content/articlelanding/2019/bm/c9bm00541b#!divAbstract
83	Ihab Ali	2019	Human	isolation	***MelSCs*****	tissue	ICC	http://www.indianjournals.com/ijor.aspx?target=ijor:ijphrd&volume=10&issue=5&article=233
84	Khalid B. Arif	2019	Human	Marker expression	Breast cancer	tissue	ICC	https://www.researchgate.net/profile/Khalid_Arif5
85	Abdullatif A. Aljuboury	2019	Human	clinical trail	Dental stem cell	tooth	Clinical response criteria	http://www.indianjournals.com/ijor.aspx?target=ijor:ijphrd&volume=10&issue=10&article=171
86	Abdulmajeed A. Homadi	2019	Human	clinical trail	mononuclear cell	bone marrow	Clinical response criteria	https://medcraveonline.com/JSRT/JSRT-05-00129.pdf
87	Ahmed M. Alshammari	2017	Mouse	treatment	MSCs	tissue	ICC	https://www.researchgate.net/publication/317498679
88	Ihab N. Safi	2019	Rabbit	treatment	MSCs	tooth	ICC	https://www.researchgate.net/publication/335716531
89	Rafal H. Abdalla	2016	Mouse	differentiation	MSCs	bone marrow	Scanning electron microscope	https://www.sciencedirect.com/science/article/abs/pii/S0891061816301326
90	Ihab N. Safi	2020	Human	isolation	hPDLSCs********	tooth	Scanning electron microscope	http://creativecommons.org/licenses/by-nc-nd/4.0/

	Authors first name	Year	Type of organism	Type of study	Type of sample	Type of organ, tissue, cell	Technique	Link
91	Ghada Firas Faisal	2019	Human	Evaluation of the Level of Stem Cell Factor	Stem cell factors	follicular fluid stem cells	enzyme-linked immunosorbent assay.	https://www.semanticscholar.org/paper/Evaluation-of-the-Level-of-Stem-Cell-Factor-in-and-Faisal-Al-kawaz/1384938bef0b54bdaa77ddbedd8a9cbb2a1ca0eb
92	Fakhraldin Marwan Flaih	2022	Human	Clinical trail	Stem cell transplantation	Bone disease from Multiple Myeloma patients	Clinical response criteria	https://www.semanticscholar.org/paper/Assessment-of-Bone-Disease-in-Multiple-Myeloma-Stem-Flaih-aqabi/99df30f24b671f02b0f06c38da3ee771b9d5cb58
93	Ahmed Kadhim Munahi	2023	Dog	Treatment: Regeneration of Acute Spinal Cord Injury	MSCs	Adipose tissue	IHC	https://scholar.google.com/citations?view_op=view_citation&hl=en&user=D1a3u_wAAAAJ&citation_for_view=D1a3u_wAAAAJ:mVmsd5A6BfQC
94	Nibras Hatim Khamees	2023	Human	differentiation	MSCs	bmMSCs** ********	ICC & microscopic	https://journals.lww.com/mtmj/Fulltext/2022/21020/The_Impact_of_Media_Supplement_on_the_Viability,.12.aspx
95	Wissam Abdullah Alhayani	2022	Rat	treatment	MSCs	Skin wound healing	Microscopic & IHC	https://www.semanticscholar.org/paper/The-Efficacy-of-Mesenchymal-Stem-Cells-loaded-in-on-Alhayani/0a252c59bba1e47c3ca7bafd5e0a0b2565fa5d4f
96	Aqeel Kazim Mohsen	2024	Human	treatment	Adipose stem cells	Adipose tissue	Clinical responses	https://iasj.rdd.edu.iq/journals/uploads/2025/08/14/97efdb2b553564b7d60bbdd035d78991.pdf
97	Furqan M. Abdulelah	2022	Human	Case study	Stem cells transplantation	HSCs	Clinical responses	https://doi.org/10.32947/ajps.v22i4.958
98	Abdullah, Safyia Khalid	2023	Human	Molecular study	Gastric Epithelial Stem Cells	Gastric disease	Gene expression	https://journals.lww.com/mtmj/fulltext/2023/22010/analysis_of_correlation_between_the_important.18.aspx
99	Ghassan Khudhair Esmae	2024	Mice	Histopathological study	bmMSCs	liver	IHC	https://doaj.org/article/3c8d52f984f941f593202f39dd4fcf1d
100	Maryam Abdhlkadhum	2021	Human	Evaluated autologous hemopoietic stem cell transplant. cohort study	Bone marrow transplantation	Bone marrow for Hodgkin disease	Clinical responses	https://journals.lww.com/ijhm/fulltext/2021/10010/the_outcome_of_relapsed_refractory_hodgkin_s.11.aspx_
101	Alsajri , Alaa Hussein	2022	Human	Case report	Bone marrow transplantation	Bone marrow with Hodgkin disease	Clinical responses	https://journals.lww.com/ijhm/fulltext/2022/11020/cross_allergic_reactions_between_etoposide_and.19.aspx
102	Maeda H. Mohammad	2023	Mouse	isolation	NSCs**	MSCs	ICC	https://bsj.uobaghdad.edu.iq/index.php/BSJ/article/view/7280

* MSCs: Mesenchymal stem cells
** NSCs: Neural stem cells
***UCBSCs: Umbilical cord blood stem cells
**** HSCs: Hematopoietic stem cells
***** ESCs: Embryonic stem cells
****** PBSCs: Peripheral blood stem cells
******* hiPSC-CMs: Human induced pluripotent stem cells
******** MelSCs: Melanocyte stem cells
********* hPDLSCs: periodontal ligament stem cells
********** bmMSCs: Bone marrow-derived mesenchymal stem cells

Review articles

The Iraqi review articles included in this analysis were published between 2007 and 2023, comprising a total of 21 articles (Table 1). As shown in Figure 3, the highest proportion of these reviews (23.81%) were published in 2022, followed by 14.29% in both 2023 and 2020. The topics covered by these review articles are diverse. Many provide general overviews of stem cells, discussing their classification, biological importance, and therapeutic applications[6-8]. Specific areas of focus include hematopoietic stem cell transplantation[6], stem cells present in periodontal cells [7], and follicular vitiligo[8]. Several articles examine the therapeutic characteristics of stem cells[9-12], with a particular emphasis on their role in cancer therapy[12]. One study describes cancer stem cells as the dark side of stem cells [13]. Finally, a noteworthy review published in 2014[14] discusses the legal and ethical conditions necessary for extracting stem cells from the human body for use in treatment or transplantation.

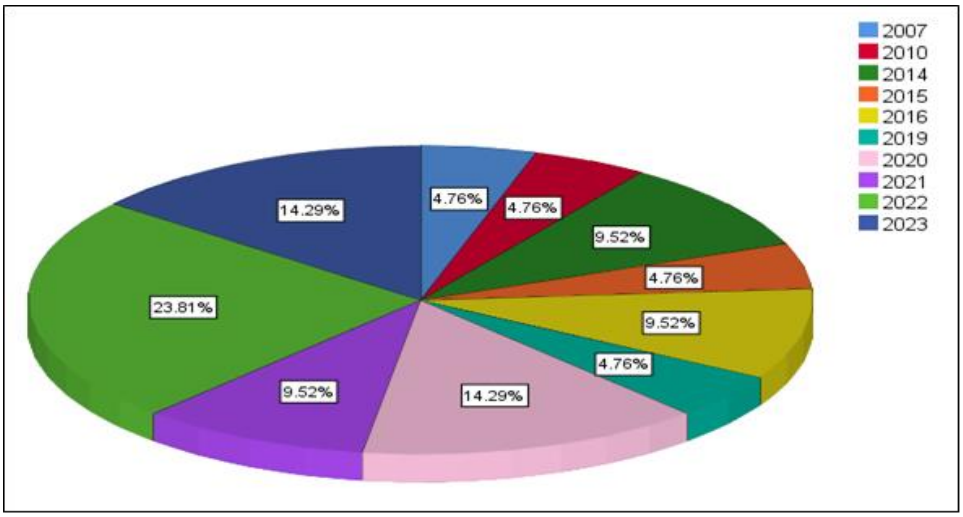

Figure 3. Stem cell publication years of the review studies included in the systematic review

Cancer stem cell articles

The Iraqi cancer stem cell articles published between 2008 and 2024 included 9 articles (Table 2). As shown in Figure 4, the highest proportion (33.33%) was published in 2019, followed by 22.22% in 2018. The remaining articles were distributed across 2008, 2014, 2017, and 2024, each representing 11.11% of the total.

Figure 4. The publication of years of the cancer stem cell studies included in the systematic review

All the cancer stem cell articles used human samples in their studies. The majority (77.78%) used tissue samples, while only one study [15] used a cell line, and another [16] used samples from AML patients (11.1% each) (Figure 5).

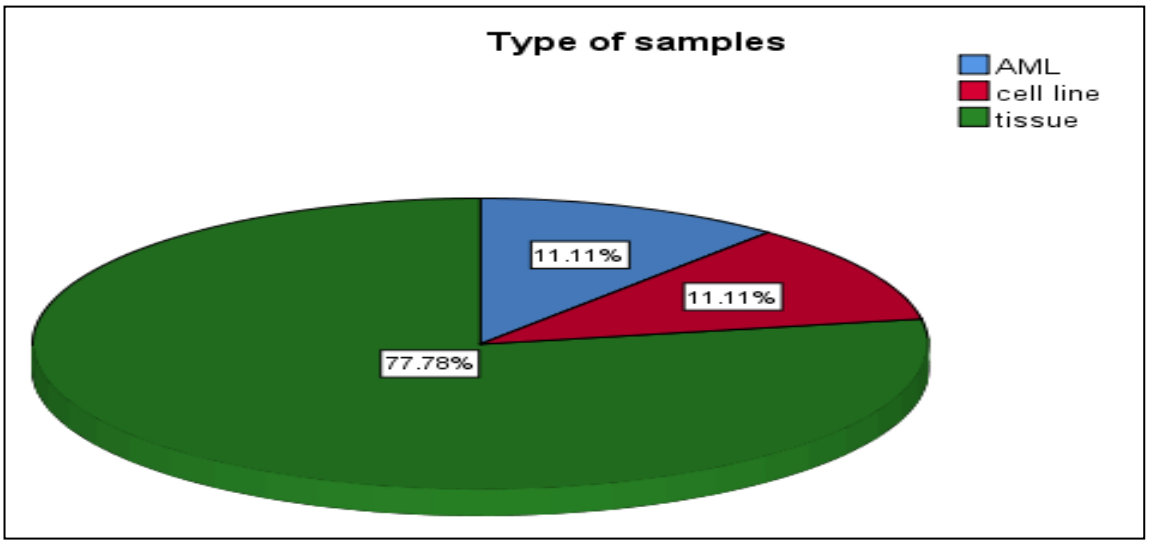

Figure 5. Types of samples of cancer stem cell studies included in the systematic review

The immunohistochemistry (IHC) technique was the most commonly used (66.67%), whereas molecular studies accounted for 22.22% and immunocytochemistry (ICC) for 11.11% (Table 2, Figure 6).

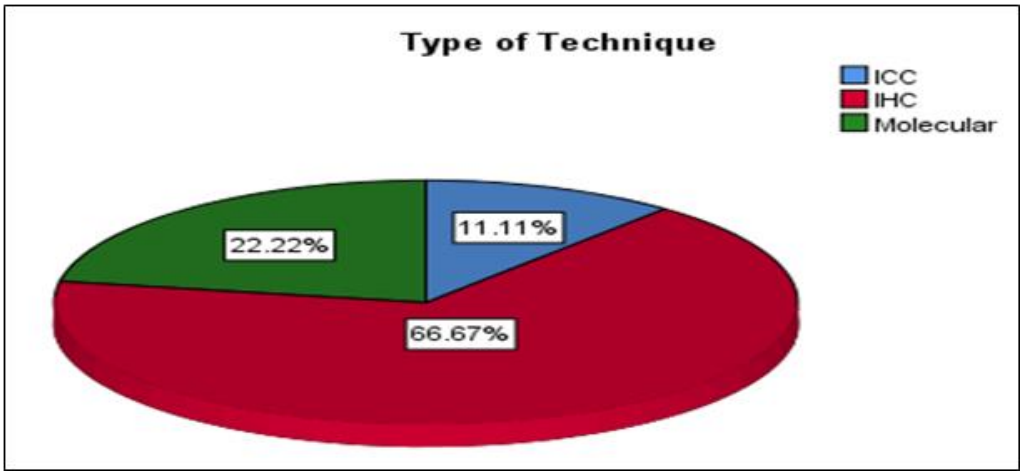

Figure 6.Types of samples in the cancer stem cell studies included in the systematic review

Methodological studies

The Iraqi methodological articles published between 1977 and 2024 included 102 studies (Table 3). As shown in Figure 7, 15.7% of these were published in 2019, followed by 12.7% in 2016 and 8.8% in 2015.

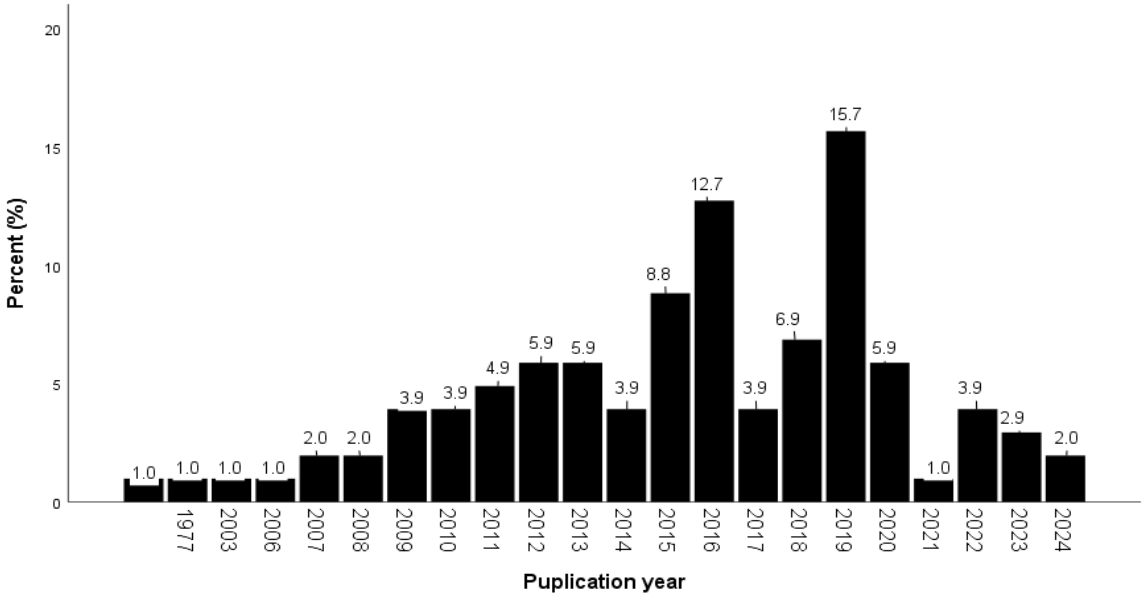

Figure 7. The percentages of publication years of methodological studies through 47 years

Among the methodological studies, the highest proportion (42.2%) utilized human samples, followed by studies employing mice (29.4%) and rats (12.7%) (Figure 8).

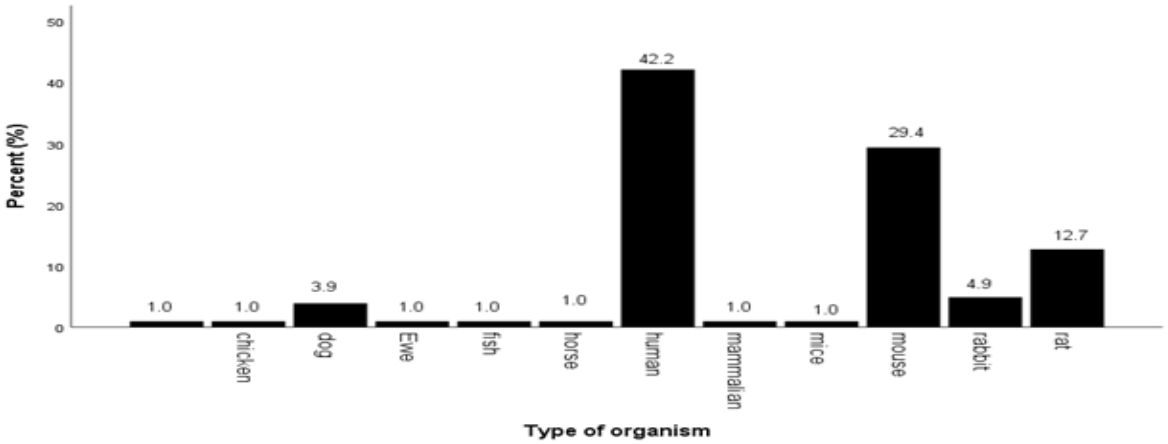

Figure 8. Percentages of different types of organisms included in the methodological studies

Differentiation studies accounted for the highest proportion (21.6%) of the methodological studies, followed by treatment-focused studies (20.6%) and cell isolation studies (14.7%) (Figure 9). Most studies used mesenchymal stem cells (MSCs) as their primary cell source (48.0%), followed by hematopoietic stem cells (HSCs) (7.8%) and umbilical cord blood stem cells (UCBSCs) (6.9%) (Figure 10). The most common tissue source was bone marrow (48.0%), as shown in Figure 11. In addition, immunocytochemistry (ICC) was the most frequently used technique (35.3%), whereas immunohistochemistry (IHC) was employed in 20.6% of studies (Figure 12).

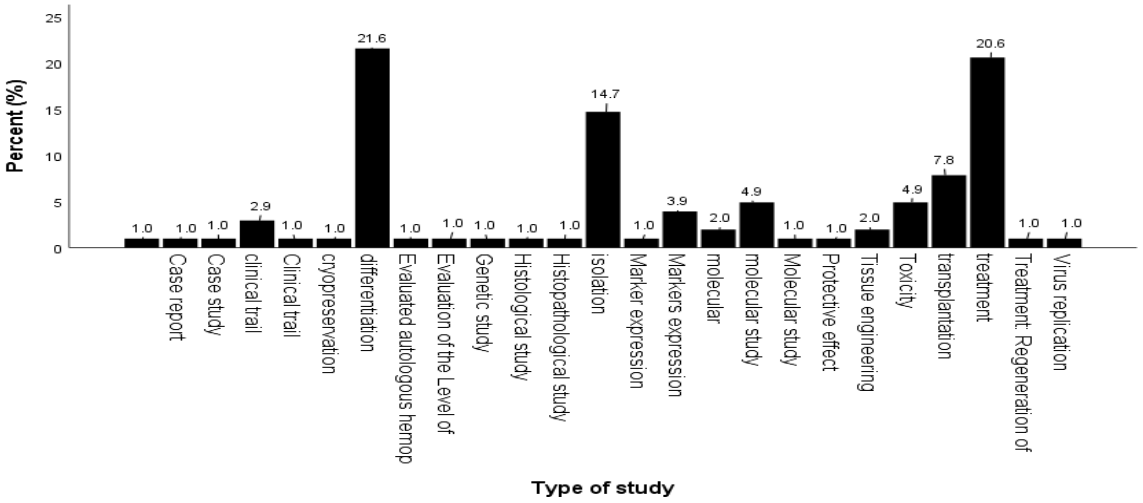

Figure 9. Percentages of different types of methodological studies

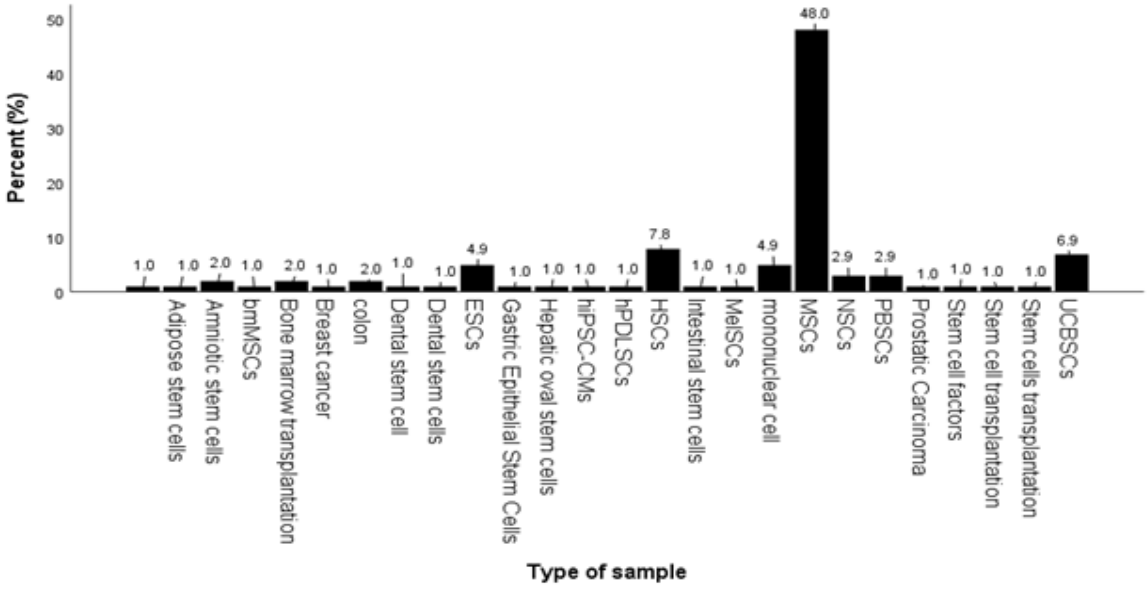

Figure 10: Percentages of different types of samples used in the methodological studies

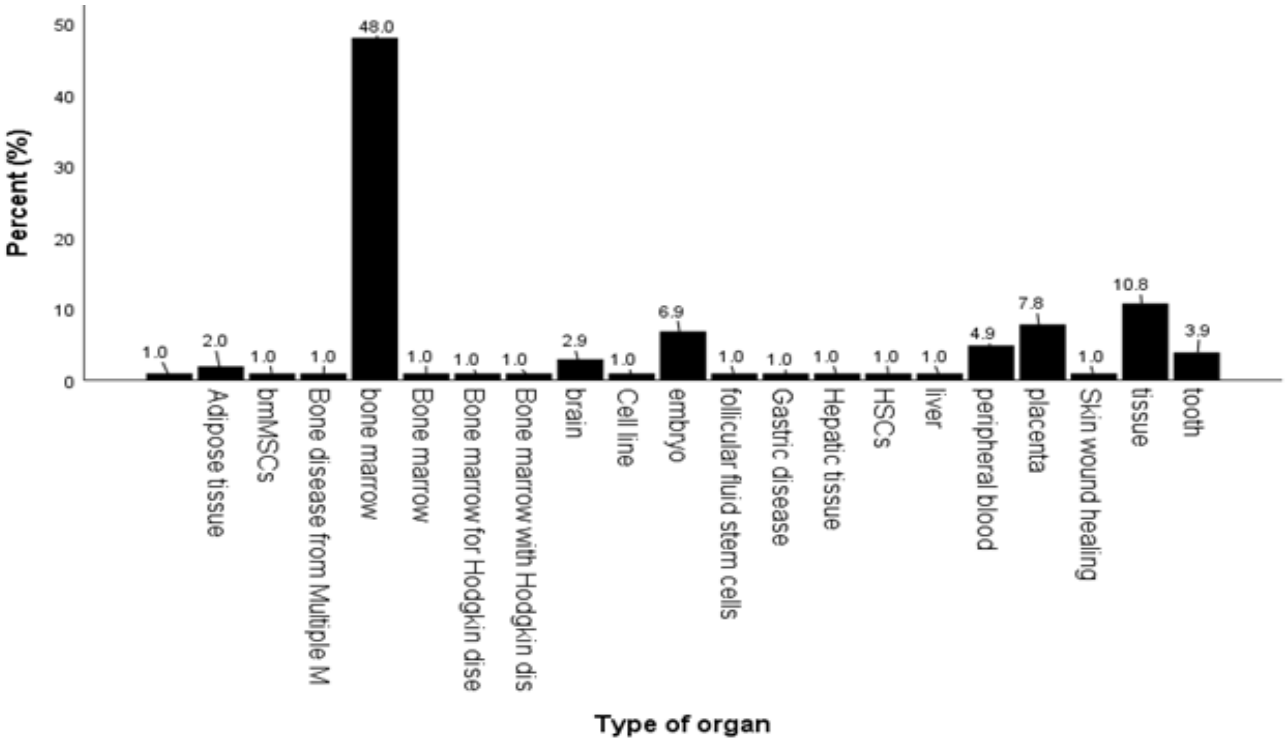

Figure 11. Percentages of different types of organs included in the methodological studies.

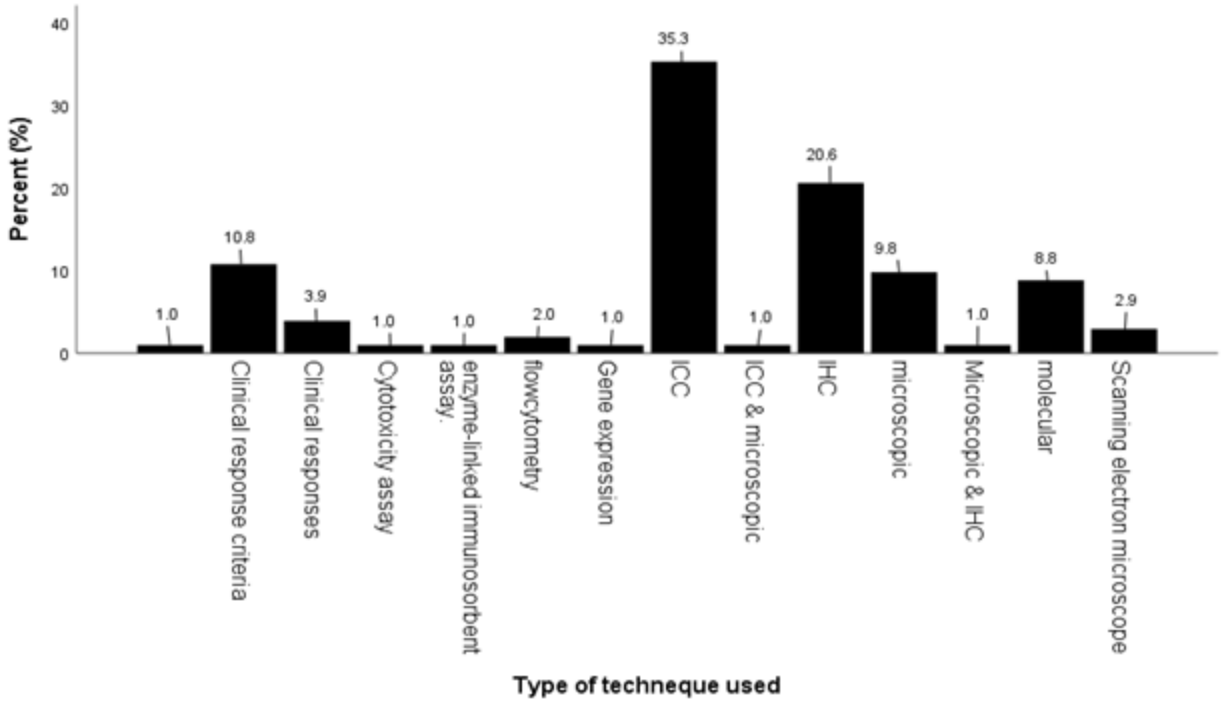

Figure 12. Percentages of different types of techniques used in methodological studies

DISCUSSION

Despite several obstacles in Iraq, a number of studies in the regenerative field—particularly in stem cell research—have focused on the isolation, detection, and differentiation of various stem cell types and their application in treating diseases.

All these studies were conducted in Iraq. The first publication in this field appeared in 1977, reporting an experimental study on stem cell isolation and proliferation in fish[17]. Subsequently, mammalian embryonic stem cells were isolated in culture [18], and later studies investigated the isolation and long-term culture capacity of adult bone marrow stem cells in albino mice [19].

Several studies have successfully induced the differentiation of different stem cell types and used them for treatment. Examples include the isolation of adult bone marrow stem cells to treat myocardial infarction in albino rats [20], the isolation of MSCs and HSCs from human umbilical cord blood to study their neurogenic differentiation[21], and the isolation and differentiation of hepatic oval stem cells from rat hepatic tissue[22]. Another study identified cancer stem cells in pediatric brain tumor gliomas[23]. Since then, the number of published stem cell studies and reviews has increased to 133 (as of the first half of 2021).

Several studies have been carried out at the Iraqi Center of Cancer and Medical Genetics Research (ICCMGR) within the Stem Cell Program in the Experimental Therapy Department of ICCMGR. This research program began with the isolation, detection, differentiation, and treatment of many types of stem cells. Initial work included the isolation and characterization of MSCs from human umbilical cord blood[21] as well as albino mice[25-27]. Several studies subsequently isolated and differentiated MSCs from mice into various cell types, including Purkinje cells[28], islets of Langerhans-like cells [29], chondrocytes [30,31], motor neuron cells[32,33], neuron cells[34], neural stem cells[35,36] , and adipose stem cells[37]. Other studies have begun to use stem cells for therapeutic applications. These include the isolation of adipose-derived MSCs to improve the repair and regeneration of induced superficial digital flexor tendon injuries in horses [38], the use of HSCs from ewe bone marrow to stimulate the immune system in immunosuppressed sheep[39], and the evaluation of autologous bone marrow-derived stem cells on tooth socket healing in diabetic rabbits compared to insulin-treated and healthy control groups[40]. One study reported the production of insulin-producing cells in diabetic mice [41]. In another study at ICCMGR, a scaffold was produced for use in regenerative medicine[42]. This scaffold was then used to isolate human periodontal ligament stem cells (hPDLSCs) by implanting them in fabricated polycaprolactone (PCL) for the regeneration of natural periodontal ligament (PDL) tissues[43]. More recently, stem cell research at ICCMGR has continued through various projects.

CONCLUSION

In the present study, we systematically reviewed all published articles on stem cells and identified 146 Iraqi research studies utilizing various methods. In conclusion, the number of stem cell studies has increased significantly over the past two decades, with a diversity of methodological approaches employed. However, due to the small number of clinical trials on stem cell transplantation therapy, limited patient enrollment, and potential bias in trial designs, there is a risk of bias in the available evidence. Therefore, further high-quality studies with larger sample sizes are needed to investigate the clinical applications of stem cells. Additionally, a centralized database for Iraqi studies across different specialties should be established.

CONFLICTS OF INTEREST

The authors declare that there are no conflicts of interest associated with this study.

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Approval by the Ethics Committee/Institution Review Board

This work was approved by the scientific committee of the Iraqi Center of Cancer and Medical Genetics Research (ICCMGR), Mustansiriyah University, Baghdad.

Data availability statement

Data supporting this study are available from the corresponding author upon reasonable request.

Funding statement

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Ethical approval statement

This ethical review project was approved by the ICCMGR scientific committee.

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